MILITARY MEDICINE, 166, 6:490, 2001

Military, Civilian, and Rural Application of the Damage Control Philosophy

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Damage control surgery is a useful salvage strategy for the most critically injured patients. Conceptually, this approach to individual patients can be extrapolated to situations such as military field surgery, civilian mass casualty events, and long-range transfers from rural areas. The logistic realities of Army forward surgery teams are addressed with regard to typical damage control maneuvers and evacuation. Specific areas requiring improvement through directed research are identified. Initial civilian mass casualty strategies are discussed, and a plan to prevent transfer delays of rural trauma patients is presented. By transferring the lessons learned from individual damage control patients to military, civilian mass casualty, and rural casualty events, resource utilization is optimized. The concept of minimal acceptable care rather than optimal trauma care can be applied to these three seemingly different situations.

Introduction

Damage control is a surgical strategy for the staged management of critically injured patients that has entered the mainstream of trauma surgery during the last decade.[1-5] It was born of the need to provide an effective surgical answer to the challenge of multivisceral injuries in exsanguinating patients, a type of trauma that carries very high mortality rates. Instead of a single definitive operation that focuses on anatomical reconstruction, the damage control strategy uses a staged approach that focuses on restoration of patient stability while temporarily sacrificing anatomical integrity. The initial operation, therefore, is a very short procedure in which only rapid temporary measures are undertaken to control bleeding and spillage of intestinal content or urine. This may entail packing of hepatic injuries, ligation of injured bowel, placement of shunts into transected arteries rather than vascular anastomosis, and rapid closure of the abdomen using a temporary plastic cover. The patient is then moved to the surgical intensive care unit, where he or she is rewarmed, coagulopathy and acidosis are corrected, and physiological stability is restored. Definitive repair of the injuries is performed during a planned reoperation several days later. The central theme of this approach is the avoidance of an irreversible physiological insult marked by the lethal self-propagating triad of hypothermia, coagulopathy, and acidosis.[6-10]

Although originally introduced as an approach to abdominal injuries, the damage control strategy has rapidly extended far beyond its original goals and represents a major paradigm shift in the care of the severely injured.[11-32] The underlying philosophy of a rapid temporary lifesaving solution followed by delayed definitive repair is being applied to situations in which surgical resources are limited or normal optimal care for multiple casualties is not an option. These situations, which are of special interest to military medical personnel, include field surgery in military conflicts, mass casualty incidents, and complex trauma in the rural setting.

Military Field Surgery

The U.S. Army has routinely utilized damage control surgery concepts since at least World War II. The Army surgical teams on the L.S.T.s (landing ship, tank) tasked with clearing the beaches of Normandy were instructed to perform lifesaving surgery only, and to not operate on casualties who could wait until England was reached.[33] While not specifically called damage control, we feel this certainly qualifies.

The U.S. Army forward surgery team (FST) is a rapidly mobile, forward-deployed small surgical unit that can perform two procedures simultaneously and has limited resuscitative capability. These teams are designed to operate on only the most severely injured patients (10–15% of all wounded) and must rapidly evacuate postoperative patients because of the very limited availability of surgical personnel, supplies, and holding facilities. This type of surgery requires rapid, resource-sparing surgical interventions. Therefore, it is not surprising that the philosophy of damage control surgery has become integrated into the FST doctrine as forward resuscitative surgery.[34]

The civilian level 1 trauma center experience describing a rapid damage control operative procedure is initially very appealing when one considers the extremely austere combat environment in which the FST is designed to function. However, the adaptation of damage control principles to the military setting may be more problematic than initially thought. The concept of damage control has an important role on the battlefield, but the precise mode of its application must be carefully considered. The first key issue is patient selection. Under the best of circumstances, damage control patients have a 50% survival in large level 1 trauma centers.[5] These centers have essentially unlimited operative and critical care resources that can be brought to bear on a single patient. Adjunctive interventions commonly used in the immediate postoperative period include blood component transfusions, interventional angiography, multiple rewarming maneuvers and devices, computed tomography, and Swan-Ganz catheters. None of these critical adjunctive measures are available to the Army FST, and because of space and weight constraints, they cannot and should not be deployed.

Certainly, the initial operative component of a civilian damage control procedure can be performed by the FST, but the typical

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The opinions expressed herein are the private views of the authors and are not to be construed as official or reflecting the views of the U.S. Department of the Army or the U.S. Department of Defense.
This manuscript was received for review in March 2000. The revised manuscript was accepted for publication in September 2000.

intensive care unit (ICU) component cannot. Patients who would have only a 50% survival in the civilian sector may not be candidates for operative intervention in the military mass casualty surgery environment. Thus, careful triage and mature surgical judgment, considering all of the tactical and logistical variables, are required to avoid expending extremely limited surgical resources, personnel, and time on these most seriously injured patients. Patients who would be typical resource-intensive damage control patients in the civilian trauma center probably will be expectant in the military mass casualty situation.

The authors believe that damage control tactics belong in the FST and need to remain part of the FST doctrine. In the forward surgery environment, the indication to use damage control maneuvers may be based primarily on the need to decrease operative time for all patients rather than on the abnormal physiology of a single patient. Thus, patients who would not undergo a damage control procedure in the civilian world may have this approach used in the FST setting, under the concept of minimal acceptable care. This approach may allow more patients to reach the operating table in a shorter time, maximizing the benefits of forward operative intervention to as many patients as possible.

The most important unresolved issue is how to provide adequate postoperative care for damage control patients. Fundamentally linked with rapid operative intervention is the ICU phase of damage control, during which aggressive rewarming, invasive monitoring, transfusion of red cells, fresh frozen plasma, and platelets, and many other supportive interventions commonly take place.[35,36] It is important to emphasize that only packed red blood cells, arterial catheters, urinary bladder catheters, oxygen, and ventilators are currently available to the FST. So although the surgical assets are available to perform the initial damage control procedure, those required for the typical ICU phase of care are not.

This critical gap in advanced postoperative care will be filled in the future by innovative technological solutions. Paramount among these are rewarming and hemorrhage control.[35–39] Lightweight and definitive modalities of improved hemorrhage control and rapid core rewarming and advances in continuous noninvasive monitoring, coagulation component replacement, and fresh whole blood transfusion practices must be either developed or, where currently commercially available, deployed to the FST. Doctrinal requirements coupled with practical research, both driven by critical evaluation of recent casualty events, will ensure that these goals are achieved.[40]

Once patients have undergone damage control procedures and survived the initial ICU phase of care, they must be evacuated rapidly from the forward area of operations. These patients are as stable as the FST can make them and must be returned to the rear for definitive reoperation. Recognizing this need, the U.S. Air Force has developed and fielded critical care air transport teams to assist in the evacuation of these "stabilized" patients.[41] The physicians, nurses, and medical technicians on these teams must be familiar with the intricacies of caring for this type of patient and should not have their initial encounter with an intubated, gauze-packed, temporarily closed abdomen, extra-anatomic vascular shunt, or abdominal compartment syndrome in the back of a military air transport vehicle (C-130 or C-141).

Accepted triage principles dictate that in the face of minimal resources and overwhelming casualties, severely injured patients may not be operated on, thereby ensuring their deaths. Adapting damage control concepts to the logistic realities of the FST, coupled with rapid evacuation by personnel skilled in surgical critical care and the interventions required by damage control patients, may improve the survival of these seriously injured yet potentially salvageable patients.

Civilian Mass Casualty Incidents

Fixed military and civilian medical facilities are occasionally called on to face the challenges of mass casualty incidents.[42–47] This is another case in which the application of damage control principles is the key to better trauma care. Disaster planning defines principles and provides guidelines for the organization of medical care in mass casualty situations but does not address the methods and means of surgical care in these adverse circumstances. It is implied that, after effective triage, the management of the individual patient in a mass casualty event is based on accepted standards of practice as defined by the Advanced Trauma Life Support (ATLS) course.[48] This implied assumption is incorrect, because ATLS is designed to provide optimal care to individual wounded patients, whereas in a mass casualty situation the focus is on providing care to a maximal number of salvageable patients, accepting that it will be suboptimal given the hostile circumstances. The only way to cope effectively with a large number of patients is by applying the general philosophy of damage control to the situation, accepting temporary suboptimal care and deliberately delaying definitive diagnosis and treatment of non-life-threatening injuries.

There are two distinct phases of care in a mass casualty incident. The first phase is during the ongoing arrival of patients, when the magnitude of the event is still unknown and communication to the scene is poor. The major concern at this stage is conservation of key hospital resources and facilities such as trauma resuscitation bays, operating rooms, imaging technology, and blood. This can be achieved only by instituting a policy of temporary minimal acceptable care for stable patients. Examples include empirical temporary immobilization of suspected fractures without X-ray and the administration of intravenous fluids, antibiotics, and nasogastric decompression to hemodynamically stable patients with penetrating abdominal trauma. These patients are transferred rapidly to the hospital wards to await definitive care later. At this phase, only critically injured but salvageable patients have immediate access to the key hospital facilities and resources mentioned above.

The second (definitive) phase of care begins when patients are no longer arriving. With a well-defined patient load and full mobilization of hospital resources, retriage with all necessary information is possible. The situation is more controlled, and it is possible, therefore, to provide definitive care to all patients in a graded, priority-oriented manner. This new approach to mass casualty events was used successfully during urban terrorist bombing incidents in Israel. Although no direct comparison with traditional methods was undertaken, the clinical impression of the incident managers and command physicians was that this new approach was clearly superior.[49] As in the forward surgery setting, the indication for a staged approach and delayed definitive care is not the individual patient's physiology but the

boundaries of the logistical and organizational capabilities of the facility facing the multiple casualty incident. Different from the combat field situation is the ability to hold the patients in an established definitive care facility and reoperate when indicated.

Rural Trauma Transfers

The rural trauma setting, with its often suboptimal surgical resources and long transfer times, is of particular interest to military surgeons and planners, especially in the context of operations other than war. Despite the obvious differences, these environments offer many of the same problems encountered in military casualty evacuation. Trauma outcomes for victims of trauma in rural areas have historically been poorer than in metropolitan areas.[50] In rural areas, there often are delays in locating trauma victims, delays in treatment at the closest facility, and delays in transport to regional trauma centers. These delays can add up to hours of valuable time lost before injuries are fully treated, even if care is expeditious. To compound the problem, initial hospital care frequently consists of diagnostic studies, most often imaging studies, for conditions that will not be treated at that facility. Computed tomography and extensive spinal radiography are common examples. In 174 of 953 patients transported to our trauma center from rural hospitals with complete registry information during a 10-year period, the mean time from injury to arrival at our trauma center was 288 ± 207 minutes. Time spent at the initial receiving hospital averaged 132 ± 127 minutes.

There is no question that a thorough evaluation of these injured patients is necessary using ATLS guidelines. Immediate life-threatening injuries such as airway compromise and tension pneumothorax must be treated quickly. However, beyond that, the principle of minimal acceptable care should be followed. Unless patients are to receive definitive care then and there, efforts should be directed at transport to a trauma center as quickly as possible. Airways should be secured, intravenous catheters placed, spines and extremities immobilized, and patients transported. There is no need for transferring hospitals to discover and catalog all injuries. Time would be better spent arranging and discussing transfer with the receiving hospital and surgeon.

Minimal acceptable care would be as follows: control external bleeding; secure the airway; immobilize the spine (if appropriate); ensure adequate ventilation (both lungs); establish intravenous access; perform baseline neurologic examinations, including determination of Glasgow Coma Scale score and motor and sensory assessment; immobilize extremity fractures as well as possible; and contact the receiving hospital to arrange transfer.

What about patients in shock? Should unstable patients be transported to trauma centers? If there is no ability to control shock at the sending facility (i.e., no surgeon or resources to respond immediately), the unequivocal answer is yes. Amazingly, physiological instability has been found to be the most common reason for noncompliance with prehospital triage protocols.[51] Yet, physiological status is the best predictor of major trauma.[52] If surgeons are available where the patient is, the prudent tack is to control bleeding and then transport, if necessary. This is damage control at its essence. For multiple or complex injuries that will require capabilities and resources beyond the scope of a hospital, arrest of hemorrhage and temporizing of other injuries followed by expeditious transport should be the goal.

Damage control surgery as practiced in the rural setting would be as follows: operative procedures designed to control ongoing hemorrhage thought to be responsible for shock (chest, abdomen, extremities); extensive operations beyond the resources of the surgeon or hospital would be discouraged (these would consist of control of visceral injuries to stop ongoing peritoneal soilage); and temporizing management of other injuries.

The receiving hospital team should understand that they are part of a continuum of trauma care. Patients may arrive from rural hospitals stabilized but incompletely evaluated or with a suboptimal surgical solution. This is often not because of inadequacies at the rural hospital but because of the application of the principles of minimal acceptable care and damage control, i.e., with the goal of transporting a stabilized patient as quickly as possible to definitive care centers. These principles should be discussed at all levels of a regional trauma system so that the philosophy is shared. Only in this way can the greater mortality seen in rural trauma be improved.

Conclusion

There are more similarities in the three approaches described above than differences. All focus on rapid triage, temporizing lifesaving procedures, rapid transport, and delayed definitive repair. The extension of damage control concepts from a single procedure to a unified surgical approach is the logical result of lessons learned from individual patients. By using the approach of "minimal acceptable care," we propose that the current damage control concept be expanded to the military FST, the civilian mass casualty event, and rural trauma transfers. These situations demand that surgeons, accustomed to expending enormous resources and time on single patients, occasionally reset their priorities and rapidly provide only the minimal acceptable care to their patients. Providing care in this manner and moving those patients quickly through the treatment and/or evacuation process will maximize care to as many patients as possible. Research and development opportunities exist to better define the requirements and resources for minimal acceptable care in the described locations.

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